The Economics of Library Size: A Preliminary Inquiry

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THE SIZE OF A LIBRARY can be measured in a number of ways: (1) by the quantity of material in its collection, (2) by its circulation, (3) by the size of the population it serves, (4) by the amount of material added to its collection over time, (5) by the size of its staff, or (6) by the area of its physical facility. Obviously, this list is not exhaustive.

Regardless of the measure one uses, a basic question facing an administrator is how large a particular library should become. This paper examines that issue primarily from the standpoint of economics. It explores the relationship between the size of a library and the total cost of operating it in an effort to reach an initial understanding of the economic implications of variations in library size. This analysis will not deal with the question of quality differences between libraries, simply because there are no generally accepted measures of quality.[1]

Attempts have been made to suggest how the maximum or ideal size of a library is established. Gore, for example, delineates three approaches: (1) the "Alexandria" idea, wherein one acquires everything and keeps it forever; (2) the "philosophical" answer, which holds that only items necessary to meet the objectives of the library are retained; and (3) the "scientific" approach, in which formulae are developed to determine the "correct" size of a collection or facility.[2] (Examples of the last approach may be found in the work of Clapp and Jordan, McInnis, and Douglass.[3]) Buckland and Hindle elaborate on Gore's second strategy by suggesting that one's objectives do, in fact, influence size and that these objectives in-

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clude collection completeness, document availability, "browsability," adequate circulation, and maximum document exposure.[4]

SIZE AS A UNIFYING CONCEPT

While appropriate institutional size is the most obvious size question, it is not the only one. The concept of size can also unify many separate library research and problem areas.

Consider, for example, depository storage facilities to hold the little-used portion of a library collection. These facilities are created because space and financial limitations prevent housing the entire collection in one place. Models of use, scattering and obsolescence of materials are attempts to identify characteristics of core collections. The primary purpose of that research is to help develop procedures for economizing on the quantity of materials needed and to eliminate certain materials from a collection as their use declines.

The current plans of a number of libraries to close their card catalogs, stemming from the initiative of the Library of Congress, are presumably related to problems in catalog inconsistencies, changes in cataloging and filing rules, and the size of the catalog which prevents any meaningful maintenance and revision, let alone effective access.

Cooperative library efforts, such as library consortia and networks, result in several activities. Among these are the construction of centralized common facilities; joint acquisition, cataloging and processing of library materials; division of collecting responsibilities; production of union lists and catalogs; shared staff; and joint storage of materials. These activities are motivated by a number of considerations, including politics, economics and effectiveness, and often lead to changes in an organization's size.

The library as an organizational unit is itself subject to size analysis. The impact of size on the library's organizational structure must be considered in terms of the relationships between size and division of labor, size and bureaucratization, and size and complexity of the library. Also important is the impact of size on the organization's members: how do morale, productivity, performance, absenteeism, job satisfaction, and stress on an individual change as the organizational size changes? Finally, the impact of organization size on its administrative component must be considered.

Architectural questions can also be considered within this analysis. The placement and layout of a library building, and the personal space needs of the users are physical, psychological and sociological factors related to size.

Locational requirements constitute the final dimension to an analysis of library size. Locational analysis pinpoints concentrations of potential library users, determines the types of demands these users will place on a library facility, and considers the transportation costs to and from user population centers. This information is useful in resolving issues such as the number of libraries (or branches) required, and the location and size of each branch.

THE CONCEPT OF ECONOMIES OF SCALE

Of these many size considerations, emphasis here is on the economic implications of changes in library size. One approach is to analyze how the cost of operating a library varies with its size. Specifically, consider that a library has some observable output. This includes materials cataloged, reference questions answered, and items circulated. The total cost of operating a library includes salaries and wages, as well as book purchases and many other factors. The average cost of a unit of output for a particular library over a specific period of time can be calculated by dividing total cost by the number of units of output. This simple step requires that an appropriate measure of output be defined and that the measure be as representative of the library's functions as possible — no trivial task.

The sources of cost data for such studies are normally accounting records, but may also be engineering studies. The problem with accounting data is that materials and labor are valued according to legal and tax regulations rather than economic rationale. Engineering cost data are inadequate in that not all organizational costs are normally included, but only those costs related to the process being studied.

The average cost per unit of output for one library over a specified time period can be compared to the same library's average unit cost for successive time periods to ascertain the general trend over time. This is time-series analysis, as opposed to cross-sectional analysis which compares the unit costs for many libraries for one time period. The latter approach is used in this paper.

The results of cost analysis can be displayed by plotting the cost per unit of output on the y-axis of a graph and the measure of output on the x-axis. In cross-sectional analysis, a unit cost/output value is plotted for each library. Three generally accepted hypotheses concerning the long-run average cost curve result from such a display. The first is that the average cost curve is U-shaped: at small levels of output average costs are high, and as output increases the average cost declines to some minimum value (the bottom of the U), and beyond that level of output the average cost rises. The second hypothesis is that the average cost curve is linear: as output increases, average cost decreases at a constant rate. The third hypothesis is that the curve is roughly L-shaped: for small output levels the average cost is high, but as output levels increase the average cost declines and approaches some asymptote.

In a comparison of libraries of different sizes, the U-shaped curve will indicate a level of optput at which costs are minimized. If the average cost curve were linear, the implication would be that large output levels are less costly per unit than small ones. Finally, an L-shaped curve indicates that beyond a certain level of output, unit costs cannot be expected to decline appreciably.

An alternate approach to the evaluation of scale economies is through the use of a production function rather than a cost function. The production function relates input factors, such as labor, materials and capital, to a measure of output. A cost function, in contrast, relates the total cost of operating the organization to measures of output. Both models are useful in determining whether scale economies exist.

Analysis of organizations in terms of their long-term average cost curves began in the private sector where the emphasis was on determining the size of a firm having the lowest average cost of production or the highest level of profit. The motivation for such analysis has broadened to include determination of a size which allows productive resources to be used more efficiently.[5] The use of economies of scale analysis is not, however, confined to private enterprise. In public organizations it is used to determine: (1) how big a facility (e.g., hospital, school, recreational facility, or sewage plant) should be; (2) what size a service area (e.g., centralized or decentralized employment office facilities, educational facilities, refuse collection or purchasing) should be; and (3) how the responsibility for public programs and activities should be divided (e.g., allocated among government agencies).[6]

The application of this technique is not without its difficulties. In-depth comparisons of organizations must take into account variations in quantity and quality, as well as variations in the prices paid for labor and materials. In analysis of government agencies, a frequent problem is that not all relevant costs will show up in an organization's books.[7] For example, sometimes a library's billing for overdue book fines is done by a finance department outside the library without direct recharge to the library.

SOURCES OF ECONOMIES AND DISECONOMIES OF SCALE

Scale analysis has three possible outcomes, depending on whether long-run average costs increase, decrease or remain the same as size increases. If the average cost increases more than proportionately to size, diseconomies of scale are present. Should average cost decrease more than proportionately to size, economies of scale exist. When the relationship remains the same, returns to scale are constant.

A number of factors explain why economies and diseconomies of scale occur.[8] One is the indivisibility (or "lumpiness") of certain equipment or special skills. A manufacturing plant cannot purchase half of a large computer-controlled milling machine even if only half the machine's output is needed. To a certain point, this indivisibility results in higher average cost, but then excess capacity is absorbed and average costs decline. At some point, however, the machine cannot be utilized further and its comparative advantage ceases.

Increased specialization of equipment and labor also contributes to economies and diseconomies. The scale of one library's technical processing operation may allow the luxury of a full-time Slavic cataloger, while in another, one person may catalog all materials. The inefficiencies of a general-purpose employee must be weighed against the need for special skills and the economies of such an arrangement.

The move toward increased specialization is limited by problems of coordination and management. As an organization increases in size, its administrative component may grow in complexity and inhibit economies that might otherwise result. While a large administrative staff may have special skills which allow it to deal with problems more effectively, a small staff may be more flexible in meeting user and customer needs. This flexibility may extend into the area of research and development, where there is some evidence that in smaller firms the technical capabilities of people are higher, research and development costs are of more concern, and communication and coordination problems are fewer.[9]

The absolute size of an organization may also have advantages and disadvantages with respect to the number of customers served, the distribution requirements, and the procurement and inventorying of supplies. The more customers an organization has, the more stable the demand for its products and services. Distribution of services is usually more costly when the service area is large, but along with management, is usually more efficient. Purchasing in large quantities can result in increased discounts, and a large facility may need proportionately fewer repairs and maintenance personnel than a small one.

Another factor which can influence the economies of operation is the extent of vertical integration, i.e., the integration of preceding and succeeding productive processes.[10] In industry, a company that performs all tasks from the production of the raw material through the distribution of the final product is an example of extreme vertical integration. This concept is applicable to library technical processing operations. Economies or diseconomies can result when materials processing is fragmented due to a branch library structure or the intervention of outside vendors (for example, in catalog card production). The scale of the library is changed as functions are added or removed from its operations.

REVIEW OF EMPIRICAL STUDIES OF SCALE ECONOMIES

A number of studies in both public and private organizations have attempted to determine the shape of the average cost curve using both cost and production functions. Mansfield summarizes many of the results reported by Walters as well as those of a few more recent studies.[11] Hirsch does the same for public enterprises.[12] Cohn reviews the applications in the field of education.[13] Mansfield's summary of cost function studies covers industries ranging from manufacturing firms, retailing, and raw material production (steel, coal and cement) to utilities (gas and electric) and transportation (railways, airlines and roads). The results are as varied as the industries themselves, and the only semblance of a trend is found in the cross-sectional studies of public utilities where long-run average costs seem to be either constant or declining. Hirsch's summary shows the same lack of pattern, and conclusions about the shape of the curve differ even among studies of the same governmental function. In general, however, there is little evidence to support the idea that most long-run average cost curves are U-shaped; the results seem to indicate an L-shaped or flat curve.

Two studies of economies in library-related fields are worthy of note. The first, by Baumol and Braunstein, examines scale economies in the journal publishing industry.[14] The authors analyzed data from 168 publishers producing from 1 to 36 journals each, and found that the average costs of the largest publisher were about 80 percent of those of the smallest. A second part of their analysis attempted to determine if a publisher who issued both original research journals and translations of foreign language journals experienced economies. From a small number of observations, they concluded that little was to be gained by changing the scale of operation.

The second study is by Ross who used the Cobb-Douglas form of the production function to ascertain the existence of scale economies.[15] Unfortunately, the paper has technical flaws which cast some doubt on Ross's conclusions. For example, as a measure of labor input he used the number of library assistants but omitted librarians. Also, he used circulation as the only measure of output, ignoring reference service, interlibrary lending and borrowing, and technical processing.

SCALE ECONOMIES IN PUBLIC LIBRARIES

An empirical investigation was undertaken to determine whether economies or diseconomies of scale exist in public library operations. Cross-sectional institutional data from the reports of California public libraries were analyzed separately for two fiscal years, 1974/75 and 1975/76.[16] The shape of the total cost curve was estimated and from it the average cost curve was mathematically derived in an attempt to determine the shape of these curves.

The equation used to analyze the public library statistics related measures of output to the cost of providing library service. A number of output measures were used in the study, including number of volumes added; total circulation (including books, periodicals, pamphlets, nonbook materials, motion pictures, audio recordings and artwork); number of items borrowed and lent through interlibrary cooperative activities; and number of reference transactions. Total operating expenditures for the California public libraries included salaries and benefits for library and maintenance staff; expenditures for library materials (including books, periodicals, microforms, and audiovisual materials); operating costs and supplies; contract services; transfers within jurisdictions (such as payments to cities or counties for accounting services); and reimbursements to other jurisdictions (e.g., a county reimbursing a city library for services to county residents).

The data were analyzed to determine which of five models fit best. The total operating expenditures (total cost) was termed y; the number of volumes added during the year, X_1; the number of volumes borrowed through interlibrary loan (ILL), X_2; the number of volumes lent through ILL, X_3; the number of reference transactions, X_4; and the total circulation of all materials for the year, X_5. The five equations used were as follows (a and b are constants):

1. $Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5$
2. $Y = a + b_1X_1 + b_2X_1^2 + b_3X_2 + b_4X_2^2 + b_5X_3 + b_6X_3^2 + \dots$

3. $Y = a + b_1 \log X_1 + b_2 \log X_2 + \ldots + b_5 \log X_5$

4. $\log Y = \log a + b_1 \log X_1 + b_2 \log X_2 + \ldots + b_5 \log X_5$

5. $Y = a + b_1X_1 + b_2X_1^2 + b_3X_1^3 + b_4X_2 + b_5X_2^2 + b_6X_2^3 \ldots$

Equation 1 implies a linear relation between output measures and cost. As the output measures increase, there will be a proportionate increase in the total operating expenditures. In general, if the total cost function is linear, the average cost function will decline as output increases. If the data fit this model, economies of scale are probably present.

The curve represented by equation 2 is a parabola. Total cost increases to some maximum value as size increases, and then declines. The average cost curve derived from this equation exhibits economies of scale since it also declines as output increases; however, the decline is not linear.

The third and fourth equations transform the measure of output into a logarithmic form. The effect is to make what would have been a curve into a straight line. Unfortunately, there is a possibility that some of the original information is lost when taking the logarithm of a number. For a simple form of equation 3, such as $Y = a + b \log X$, the curve is concave from below if the value of b is positive and convex when b is negative. (Ezekiel and Fox provide a convenient summary of the forms of many such curves.[17])

Equation 4, a simple extension of the previous three models, can be transformed so that its shape may more easily be determined. Taking the antilogs of both sides yields:

6. $Y = aX_1^{b_1} X_2^{b_2} X_3^{b_3} X_4^{b_4} X_5^{b_5}$

To determine what type of scale economies exists in this function, the coefficients $b_1, b_2, \ldots b_n$ are summed. If the sum is greater than one, there are diseconomies of scale. If the sum is less than one, economies of scale exist; if it equals one, returns to scale are constant.*

* Equation 6 here is a cost equation. Note that when factors of production (inputs) are related to outputs, a common form that results is the Cobb-Douglas production function:

$$Q = aI_1^{b_1} I_2^{b_2} I_3^{b_3}$$

Q is the rate of output; I_1, I_2, I_3 are the quantities of labor, material and capital required to produce the output; and a and b_i are constants. Under certain assumptions it can be shown that a cost equation can be derived from a production function. *See* Walters, A.A. "Production and Cost Functions: An Econometric Survey," *Econometrica* 31:1-66, Jan.-April 1963.

The traditional form of the cost function is given in equation 5. This cubic function has two points of inflection and a general upward trend. The average cost function derived from this curve takes on the classic U-shape of a parabola, with average costs declining and then rising as output increases.

Scale economies are most clearly observed in the average, rather than the total, cost function, but this research fits total rather than average cost curves, and then derives average cost implications from them. There are two reasons for this. By far the most important is that fitting an average cost curve implies one measure that can be divided into total cost to compute average cost. This approach seems feasible, but was not attempted. The most likely method of creating a single output measure would be to weight each of the unique output measures and add them together to create a combined measure. For example, if each output variable could be weighted by the staff time required, the number of units of reference activity completed could be compared with the number of circulation transactions. However, development of such weights must await further research. The second reason for fitting total cost curves with separate independent variables, rather than a single combined output variable, is that the former approach preserves more information. Reporting the values of the regression coefficients for each output measure separately retains a better awareness of the statistical importance of these measures.

Empirical Results

The FY 1974/75 California public library data fitted to the linear total cost function (equation 1) yielded:*

$$
\begin{aligned}
7.\quad Y = {} & \underset{(-.086)}{-2{,}530.23} + \underset{(7.44)\dagger}{22.70\,X_1} - \underset{(-3.88)\dagger}{64.79\,X_2} + \underset{(4.41)\dagger}{27.27\,X_3} \\
& - \underset{(-.18)}{.0049\,X_4} + \underset{(9.17)\dagger}{.71\,X_5} \\
& R^2 = .9799 \qquad F = 1{,}570.71 \qquad n = 167
\end{aligned}
$$

This equation, while exhibiting a high F value and a high coefficient of determination (R^2), has a constant term (a) which is not significant. This

* The t statistics are given in parentheses below each coefficient in this and succeeding equations. Also, significance of the coefficients at the $\alpha = .05$ level is indicated by a dagger. The F statistics for all equations reported is significant at $\alpha = .05$.

suggests that the equation is not adequate as an explanatory tool. When the same equation was used with the FY 1975/76 data, however, the results indicated a reasonable fit:

$$8.\ Y = \underset{(-2.63)\dagger}{-74{,}791.06} + \underset{(9.10)\dagger}{24.94\,X_1} - \underset{(-.98)}{10.38\,X_2} - \underset{(-1.03)}{5.25\,X_3} - \underset{(-.13)}{.0031\,X_4} + \underset{(11.44)\dagger}{.65\,X_5}$$

$$R^2 = .9755 \qquad F = 1{,}279.38 \qquad n = 167$$

Here the constant term in the equation is significant. However, while only the constant (a) and the number of reference transactions (X_4) were not significant in the FY 1974/75 equation, in the equation for FY 1975/76, X_2 (interlibrary borrowing), X_3 (interlibrary lending), and X_4 were not significant. This suggests that the later variables add nothing to the explanatory power of the equation, even though there is a theoretical basis for their inclusion. This theoretical basis is, of course, that the library does expend its efforts on interlibrary transactions and reference activities as well as on acquisitions and circulation. The preliminary nature of the research and the need to report such results for further analysis (as was discussed earlier) justify inclusion of such variables in the equation.

When observed data points are compared with values computed from a regression equation, the two may not coincide. Analysis of the residual difference between the observed and expected values provides a clue to how closely the equation fits the observed data points. Possible results of analyzing the residuals is autocorrelation or serial correlation.

There are several ways to detect autocorrelation. The simplest is to plot the observed and estimated values to ascertain any pattern of divergence between the two. Such an analysis depends on the observed values being ordered in some meaningful way. In this study of public library data, the libraries were ranked from lowest to highest, based on a measure of work load derived from the sum of the X_i values. The autocorrelation analysis then showed how well the data fit the curve according to a rough measure of library work load. This visual analysis for both years indicated that the linear curve fit libraries with smaller work loads reasonably well, but as the size of the work load increased, the fit grew worse.

Another method of analyzing autocorrelation is computing the Von Neumann ratio.[18] For both years' data, the computations indicate that autocorrelation is present in the equations as measured by the Von Neumann ratio, thus discounting the otherwise good fit for the FY 1975/76 data.*

The parabolic curve of equation 2 produced the following results:

FY 1974/75

$$
\begin{aligned}
9.\ Y = {} & \underset{(1.09)}{34{,}787.21} + \underset{(1.53)}{8.70\,X_1} + \underset{(2.32)\dagger}{.000097\,X_1^2} + \underset{(.66)}{20.70\,X_2} - \underset{(-.52)}{.0023\,X_2^2} \\
& - \underset{(-1.14)}{16.08\,X_3} + \underset{(1.59)}{.00085\,X_3^2} + \underset{(6.78)\dagger}{1.45\,X_4} - \underset{(-7.00)\dagger}{(.842 \times 10^{-7})\,X_4^2} \\
& + \underset{(5.04)\dagger}{.715\,X_5} - \underset{(-1.85)}{.436 \times 10^{-7}\,X_5^2}
\end{aligned}
$$

$R^2 = .9870 \qquad F = 1{,}187.23 \qquad n = 167$

FY 1975/76

$$
\begin{aligned}
10.\ Y = {} & \underset{(.189)}{4{,}703.52} - \underset{(-.105)}{.592\,X_1} + \underset{(3.89)\dagger}{(.192 \times 10^{-3})\,X_1^2} + \underset{(1.43)}{32.35\,X_2} - \underset{(-1.32)}{.00175\,X_2^2} \\
& - \underset{(-.982)}{10.62\,X_3} + \underset{(1.21)}{(.380 \times 10^{-3})\,X_3^2} + \underset{(9.38)\dagger}{1.52\,X_4} - \underset{(-10.88)\dagger}{(.822 \times 10^{-7})\,X_4^2} \\
& + \underset{(6.52)\dagger}{.757\,X_5} - \underset{(-3.26)\dagger}{(.644 \times 10^{-7})\,X_5^2}
\end{aligned}
$$

$R^2 = .9879 \qquad F = 1{,}272.24 \qquad n = 167$

In both cases, the constant term is not significant at the $\alpha = .05$ level, indicating a poor fit. Furthermore, even though the coefficients of the more important quadratic terms in the equations (volumes added, reference transactions and circulation) are generally significant, the values of the standardized regression coefficients (βs) indicate that the linear terms are relatively more important in the equation than the quadratic terms, and autocorrelation is present in both equations. In summary, it appears that the data do not conform to a quadratic equation.

The third equation computes total cost as a function of the sum of the logarithms of each output measure. The computational results suggest a relatively poor fit. For FY 1974/75, only 44 percent of the variation in the dependent variable is explained by changes in the independent variable, and for FY 1975/76 the figure is 45 percent.

The results for equation 4 are as follows:

* The value of the ratio is 2.74 for FY 1974/75 and 2.53 for FY 1975/76. Since the sample size was greater than 60, a tabled Normal Distribution was consulted and the test was performed at the .05 level for this and succeeding Von Neumann ratio tests.

FY 1974/75

11. $$\operatorname{Log} Y = \underset{(2.65)\dagger}{.433} + \underset{(4.70)\dagger}{.283} \log X_1 - \underset{(-.427)}{.0062} \log X_2 + \underset{(.874)}{.0086} \log X_3$$
$$+ \underset{(.802)}{.0073} \log X_4 + \underset{(11.51)\dagger}{.726} \log X_5$$
$$R^2 = .9228 \qquad F = 384.95 \qquad n = 167$$

FY 1975/76

12. $$\operatorname{Log} Y = \underset{(5.41)\dagger}{.736} + \underset{(9.19)\dagger}{.551} \log X_1 - \underset{(-.041)}{.00058} \log X_2 - \underset{(-.753)}{.0062} \log X_3$$
$$+ \underset{(2.43)\dagger}{.0170} \log X_4 + \underset{(7.93)\dagger}{.467} \log X_5$$
$$R^2 = .9491 \qquad F = 600.31 \qquad n = 167$$

While both of these equations have slightly lower coefficients of determination than equations 7 and 8, the values are still very high. In addition, both equations have constant terms which are significant and the coefficients of volumes added and circulation are also significant. For the FY 1975/76 equation, the coefficient of reference transactions is significant as well. No autocorrelation was found in the equation for either year, based on the Von Neumann ratio test. It appears that the data for both years most closely fit this form of the equation.

Adding the b_i values in equations 11 and 12 yields 1.0382 for FY 1974/75 and 1.0287 for FY 1975/76. As explained before, if the coefficients add up to one, this indicates constant returns to scale, and if the sum is greater than one, diseconomies of scale are present. The values here are so close to one that all that can be said with any certainty is that there are no strong indicators of economies or diseconomies of scale, and there is some indication of constant returns to scale.

The data were also tested against the cubic equation, number 5. The results for both years indicated a poor fit, with constant terms not significant and autocorrelation present in each equation.

Correlation Analysis

One question that arises is whether the same result could be obtained using fewer variables in the models. To investigate this issue it is useful to examine the correlations among the five key variables. These variables for FY 1974/75 are reproduced in Table 1. The correlation matrix shows strong relationships between total expenditures and volumes added, reference transactions, and total circulation. The independent variables have

TABLE 1. Key Variables for FY 1974/75

	Total Expenditures	*Volumes Added*	*ILL Requests*	*ILL Borrowing*	*Reference Transactions*
Volumes added	.981				
ILL Requests	.511	.458			
ILL Borrowing	.204	.207	.595		
Reference Trans.	.716	.757	.073	−.014	
Total Circulation	.985	.980	.500	.228	.724

high correlations among themselves (e.g., reference and volumes added, .757; total circulation and volumes added, .980; and total circulation and reference transactions, .724). To what extent is one independent variable simply a surrogate for another? Specifically, could circulation be used instead of all the other variables with the same results? Calculating the partial correlations between the variables sheds some light on the question. For example, when the partial correlation between total circulation and volumes added is computed, controlling for the effect of reference transactions, the correlation drops slightly to .957 — still very high. The partial correlation of total circulation and reference transactions, after removing the effect of reference transactions, drops to −.063. Circulation does appear to dominate the process. The results are similar for FY 1975/76. However, the results may be due to the measure of output used. It must be remembered that the outputs are unweighted, and the results might be quite different if they were adjusted.

SUMMARY AND CONCLUSIONS

This paper is an initial investigation of the economies of library size. It has been shown that the concept of size can serve as a useful departure point from which to examine and integrate many past and current research efforts in information science. This process, however, is not without its limitations. For example, a major deficiency is the lack, in the equations, of any variables designed to measure the quality of a particular library's service. Another deficiency is the relatively straightforward measures of outputs that are used. Obviously, not all the outputs of a library are considered and, furthermore, the ones that are used are incorporated into the model in a simple manner. In other words, a unit of circulation is considered to have the same relative importance as, for example, a reference transaction. Weighting of output measures will be a next research step.

The empirical research on public libraries in California has shown that the classical U-shaped average cost curve does not exist. Rather, the evidence suggests that the best fit comes from the logarithmic model of equation number 4. This model demonstrates nearly constant returns to scale. As output levels increase, total cost increases almost proportionately, with average costs almost constant.

The policy implications of the empirical research are that larger libraries cost approximately the same to operate as smaller ones. This conclusion obviously must be balanced with the needs of the user groups, locational requirements, bibliographic access problems, and personnel considerations. It would be naïve to consider the results in isolation; they must be considered as one of many factors in the library size decision-making process.

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